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# NAVAL POSTGRADUATE SCHOOL

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## THESIS

Energy For Tomorrow: An Issue For Today

by

Leonard Paul Zakas

September 1980

Thesis Advisor:

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Energy For Tomorrow: An Issue For Today

by

Leonard Paul Zakas  
B.S., Western Illinois University, 1965

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## ABSTRACT

A methodology is presented for the development of actions needed to resolve the energy crisis. Identified is a three point program: 1) Describe an energy future for the United States based on the depletion of conventional energy sources, 2) Define the government's administrative and financial role for achieving this future, and 3) Channel government research, testing and procurement funds to the private and business sectors so that the development of appropriate technologies can commence.

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There is no energy shortage.  
There is no energy crisis.  
There is a crisis of ignorance.

R. Buckminster Fuller

## I. INTRODUCTION

Popular opinion holds that something known as an Energy Crisis was initiated by a group of Arab Nations in an area of the world known as the Middle East. The precipitous events began, in the public view, as a desperate attempt to ward off the military defeat of several "brother" countries. After a selective embargo of crude oil exports to many industrial nations quickly brought about a cessation of the military action, it did not take long for this newfound power to be flexed. When the Organization of Oil Producing Countries (OPEC) shortly afterward doubled the price of crude oil, the first cycle of a new economic principle began -- STAGFLATION: a recessionary national economy together with relatively high rates of inflation. As America's political processes were being rocked by Watergate, government intervention kept the average crude oil prices artificially low through complex pricing formulas and allocations of "old" domestic crude oil. The cheap energy and stable economy of the pre-OPEC era has, by 1980, been replaced with extraordinary high costs for all types of energy, high inflation rates and uncertain economic conditions both in the United States and abroad.

The preceding description is a reasonably factual short explanation of America's current energy and economic situation. However, it is incomplete and does not allow for an evaluation, analysis and understanding of the past events. One needs to look into the future and choose what is essential to be done now. Moreover, information must be developed to provide a basis for deciding upon any short- or long-term resolving actions.

It is not the intention of this paper to prove that there is an energy crisis, but rather to propose that the alternatives now available are, in fact, extremely limited. Implicit in this purpose is the belief that an energy future has yet to be defined despite an urgent need for today's activities to be selected so as to achieve an acceptable future (or "future model"). The information, definitions and philosophies were chosen for this paper to provide a basis to analyze and judge any proposed energy future. The future model presented as an example meets the criteria provided and is used as a basis for demonstrating the types of immediate government policies and actions which could initiate achievement of a chosen energy future.

#### A. AN ENERGY PERSPECTIVE

There was a crude oil embargo and the first OPEC price rises took place in September and December 1973; respectively. Since this is mid-1980, these world shaking events occurred almost seven years ago. It is important to remember that seven years have passed and to ask whether these seven year old occurrences are THE causes of the currently perceived state? Another question is would the actions taken to date alleviate the impact of the problems caused seven years ago by the oil embargo? And it might be asked why weren't the price increases foreseen?

Dramatic increases in the costs of energy were predicted by a study done by the Department of the Interior in 1972 /367.

This study's projections of United States Energy Through the Year 2000 were researched and published prior to OPEC's price increases. It is a significant demonstration that the "crisis" was really just a matter-of-time phenomenon rather than only "caused by OPEC."

The past three presidents of the United States have each set and revised the national energy goals. An awareness of these goals are necessary for a complete historical perspective. The initial Presidential policy was in direct response to the 1973 OPEC actions but the subsequent revisions are too often forgotten:

1. President Nixon on November 7, 1973, kicked-off PROJECT INDEPENDENCE which called for achieving an eighty-five percent energy independence by 1980 27.

2. On September 23, 1974, President Ford proclaimed to the World Energy Conference that "Independence cannot mean isolation" and that the purpose of PROJECT INDEPENDENCE is only to achieve "independence from insecure sources." 27.

3. President Carter, to a special joint session of Congress on April 20, 1977, declared that the energy problem constituted "the greatest domestic challenge our nation will face in our lifetime." The heart of the problem, warned the President, was that demand for fuel was rising more quickly than production 97.

Another widely quoted study is the Central Intelligence Agency report of 1977 167. It is significant because of its

publication only a short time after the initial OPEC actions. It predicted both world-wide shortages and the beginnings of the USSR as a competitive importer of limited crude oil production. The key points concerning crude oil supplies include:

1. Internal Soviet demand will exceed internal production by 1985.
2. Soviet commitments to its Eastern Europe satellites cannot be met by 1985.
3. World-wide supplies will be unable to meet world-wide demand by 1985.

#### B. A PROBLEM SITUATION

An unbalanced economic situation has occurred primarily due to incorrect federal government actions (price controls, depletion allowance, foreign tax credits) and to federal government inaction (lagging research and development expenditures, failure to act on reports, lack of a coordinated energy program). In addition, the inflationary energy-cost/materials-price/wage-rate spiral will continue since, even after seven years, the price/cost of energy is not yet reflecting the marketing price as set by OPEC 32. The individual consumer has been forced to reduce the number and value of his retail purchases as a result of increasing personal energy costs, increasing commodity prices caused by the energy costs to the producer/manufacturer, and wages lagging behind these increases.

The following concerns have tended to slow or stop necessary resolving actions of the various energy users and all levels of government:

1. How to pay for the increasingly costly energy?
2. What is "cost-effective" to purchase and install?
3. What is the reliability of the equipment?
4. What is the reliability of the installer?
5. How to install energy saving equipment?
6. What will be the next tax law or policy?
7. What will be the price of oil in the future?

While many "solutions" are announced, no specific energy future is evident within all the activity. Additionally, the information/idea avalanche makes it extremely difficult for any one person to stay abreast of all new developments; much less separate an idea from reality or, even harder, to decide on how to spend his wages or company profits.

#### C. PROBLEM RESOLVING

There is a distinction between "problem solving" and "defining the problem." It has become a characteristic of the industrialized western society to be "problem solvers." When a problem is encountered, it has almost become second-nature to immediately begin a mental review of solutions and, as soon as possible, implement a solution. Eastern cultures, however, often have a more pragmatic or long-term view of a problem and the first step is to define a

preferred future situation. With this idealized future in mind, the approaches to move the current situation to the preferred situation are analyzed, and an initial solution set chosen. With a problem (or situation) so multifaceted and complex as the energy future of the United States, this Eastern approach offers a more viable approach than any "quick" solutions could ever discover.

One additional problem discriminating tool is useful. A purported solution must be analyzed as to whether it is, in fact, solving the problem. While seemingly a contradiction, one may take one's own view of the energy situation and ask whether the following actions have resulted, or will result, in a solution: 1) The fifty-five mile-per-hour speed limit, 2) Price controls on domestic crude oil production, or 3) The windfall profits tax. These actions may be described as bureaucratic "firecracker" solutions because they are announced with much fanfare and speeches but do not solve the real problem. It is often easier to treat one of the symptoms than it is to solve the whole problem /137.

#### D. APPROACH

The development of a mutually acceptable future model first requires a common and reliable data base. This is comprised of a basic set of information, concepts and definitions which can then be applied to the critique of alternative and proposed solutions. Thirdly, an achievable future can be selected by

objective common sense thought processes which abstains from overly futuristic schemes (anti-gravity), avoids single-mindedness (use only coal or only solar) and accounts for the social and economic well-being of both individuals (solution needers) and the government/commercial/industrial base (solution providers). Finally, the selected energy future is used to analyze today's problems, establish the broad policies by which to make the transition to the preferred future and then chose those initial actions best suited to begin the transition. This sequence is used to develop an initial course of action for resolution of the perceived energy crisis based on a proposed model of a preferred future.

## II. BASELINE CONCEPTS

The initial concepts needed to develop an energy program are not directly related to any specific energy source. Rather, they are areas which, when more than superficially considered, are useful to analyze the feasibility of various future models and the proposed actions to achieve those models. The following baseline concepts include an easily applied mathematical concept, and some necessary definitions and philosophical approaches.

### A. A GROWTH PRINCIPLE [1]

Many of the proposals for the energy future cite percentage increases per year as proof of the simplicity of the solution. These are similar to the rates used to describe inflation, give birth and death rates, and various other growth rates. The following seemingly diverse data set can serve as an example:

- Gasoline miles-per-gallon improves 20 percent per year,
- Food production increases four percent per year,
- Birth rates are running at two percent per year,
- Inflation rates are five, seven, or ten percent per year,
- Electricity usage will increase seven percent per year, or
- A city plans to grow at seven percent per year.

These percentages each seem fairly innocuous and acceptable.



The reader might question an increase of some item if it was 50 percent per year because he could easily realize that in less than two years the item would double in quantity. Viewing a percentage change in terms of the number of years it takes to double the initial level is a reasonable, easily understandable concept. It is easy to include in any mental analysis of the meaning of the percentage. The years to double allows for a quick analysis of future requirements and obvious comparisons.

It can be shown that by dividing the number seventy (70) by the percentage increase per year, the result is a close approximation to the number of years it takes to double. The previous data can now be restated as follows:

<u>Percentage Change per Year</u>	<u>Item</u>	<u>Years to Double</u>
20	Gasoline Miles-Per-Gallon	3.5
4	Food Production	17.5
2	Birth Rate	35.0
5, 7 or 10	Inflation Rate	14, 10 or 7
10	Coal Production	7.0
7	Electricity Usage	10.0
7	City Growth	10.0

When viewed in terms of doubling time, a different perspective is given to these previously moderate percentages:

1. A modest birth rate of two percent in an underdeveloped country doubles the population in thirty-five years. Will the real growth in the economy and food production keep pace?

2. The cost of a loaf of bread was five cents and then increased to ten cents, twenty cents, and so on until today's eighty cent loaf is normal. The same sequence holds for the price of an automobile and a house. When prices will double is based on the rate of inflation that is allowed to occur.

3. The doubling of coal production in seven years requires a tremendous increase in facilities as well as transportation networks (railroad lines, coal cars and locomotives), willing and trained miners, and housing for workers and their families. Also, it has taken seven to ten years to plan, design and build a coal fired generating plant.

4. Although city leaders often propose seemingly modest growth rates of seven percent per year, the taxpaying voters often do not realize that schools, water supplies, sewage treatment plants and police departments must all be doubled in size within the next ten years.

This doubling concept can easily be applied to begin any analysis of what effects a yearly percentage change might have and what are some of the things which might limit the feasibility of maintaining such a rate.

#### B. ACTION INITIATORS

Leadership in the energy field has been and will continue to be spearheaded by multiple and diverse organizations.

Acknowledging the existence of each makes it possible to consider impact in any final overall plan.

1. The President and Staff: As the only nationally elected official and leader of the Executive Branch, the President's decisions, goals and statements can make or break most federal efforts.

2. The Federal Executive Branch: Generally the Department of Energy (DoE) will take the lead in preparing policy and budget proposals. Together with this leadership role in energy matters, DoE activities must take into account political realities as well as the responsibilities of the other Executive Branch departments. What the DoE relationships with the Department of Defense (DoD) are will be especially important due to the technical manpower and facilities under DoD control and the huge amounts of energy used by the military.

3. The Federal Legislative Branch: The Senate and House of Representatives wield significant national policy import because of their ability to create public law, apportion funds to specific projects and set tax incentive law. Since funding is apportioned to all Executive Branch Departments, the Legislature is in a position to force (or delay) implementation of energy policies by the federal government.

4. State Governments: Energy policies at the state level can be set and implemented through various tax and regulating actions. These include: establishment of tax credits, delay

of assessment increases, depreciation advantages, utility regulations and pricing, establishment of Energy Commissions or Departments with special powers.

5. City and County Governments: Although tax incentives are somewhat limited, zoning and building codes are often initially controlled at this level of government. The governments involvement in energy matters can have significant impact on the local population where energy efficiency activities are visible and available for inspection and local news coverage [6,26,27,35].

6. Special Districts: School districts, transportation and sewerage networks, and water quantity/use districts have been established to allow for a framework of mutual problem solving by adjacent cities, counties and/or states. Similar types of districts may prove useful for future mutually beneficial energy projects.

7. Cooperatives and Condominiums: These ownership alternatives offer a ready-made supporting group where energy costs are of mutual active concern.

8. Commercial/Industrial Complexes and Associations: The benefits of joint and coordinated energy saving projects among geographically close facilities or among similar types of businesses needs encouragement.

9. Community Groups/Associations: Energy savings and energy projects within a community can result in reduced taxes and new business opportunities.

10. Coordinated Neighbors: The high cost of some energy projects might best be borne by several neighbors in partnership. It will require a different perspective on zoning and land ownership if facilities/equipments are to be located on land with some type of mutual ownership.

11. Individuals: Often forgotten, the individual will still have to make the most difficult and, on a percentage basis, most costly decisions on how to overcome the high (and increasing) cost of energy. The "bringing together" of many individuals to act in a concerted manner will be a most difficult task.

#### C. CONCEPTS DEFINED

Over the years certain common terms and concepts have been applied to the energy situation which too often have developed multiple meanings. The following terms and phrases are discussed in a manner to standardize their use and meaning in this paper.

1. Alternate Energy Sources: Any source other than natural crude oil products, natural gas or nuclear energy is considered as "alternate". Coal, when used as a synthetic fuel base, is considered an alternate fuel.

2. Appropriate Energy Sources [22]: There is a rational argument that "economies of scale" may be on the reverse due to the cost of energy. For example, if it takes ten years to design and build a coal fired electric plant, might it not

be better to build several smaller plants in five years?  
Or, if an environmentally safe way to produce electricity is with hydroelectric systems, would it not be more cost effective to mass produce one thousand small units to use with existing small dams than it would be to build a large dam with a large generator?

3. Hard and Soft Technologies /18/: This separation is primarily a result of the solar industry emphasizing their "soft" technology in both active and passive approaches. Recent uses have made a distinction as to whether the heat or electricity produced uses "on-site" primary energy sources or more "hard" sources which must be transported to the site.

4. End Use of Energy: Many common activities can be segregated as to whether they require heat or whether they require electricity to properly perform their function. The usefulness of the distinction is evident once one realizes that the energy efficiency of the electricity found at the average home outlet represents only seventeen to twenty-five percent of the energy used to generate it /17/. During the years of "cheap" energy, electricity was often used to produce heat. Today, this is no longer economical in most areas nor in the national interest. When there is a heat-needing function, the effort must be made to provide that heat with as little electricity involved as possible.

5. Conventional Energy Sources: The common use of this term includes only large-to-medium scale hydroelectric

facilities and the fossil fuels used for heat and/or electricity generation. Nuclear power is not considered a conventional energy source.

6. Miscellaneous Concepts:

a. Distribution Systems /207: Energy is used to transport fossil fuels; inefficiencies arise during a combustion process; and inefficiencies of electrical transmission systems are inherent in the designs; each of these types of energy losses must be acknowledged and considered in energy solution decisions.

b. Time Constraints: Any proposed solution to the energy problem must not only include consideration of the doubling principle, but also the length of time to design and construct complex new facilities. Ten years for large refineries, hydroelectric dams and electric power plants is common. Fifteen years for new technologies such as those proposed for synthetic fuels might be appropriate.

D. SPECIAL INTERESTS

Although there are many "interest" groups that do now or will (should?) effect future energy programs, they cannot be subjected to a hierocratical type of listing as the previous Action Initiators were. This will probably continue because of the diverse nature of the problem itself as well as the diverse solutions which will be needed. Many groups and associations who have been actively involved will need to be

sought out if a coordinated energy solution is to be implemented. Additionally, there is a real need to avoid putting "bad" or "good" labels on any specific group or area of concern.

Many state and federal government agencies have been created to represent or support various "special" and "common" interest groups. The concept to be emphasized is that there are capabilities, talents and facilities available to make the difference in whether there is to be a truly successful resolution of the energy problem or just a "getting by." It is important to utilize the standards setting capability of the Department of Housing and Urban Development; the capability of the Nuclear Regulatory Commission, Rural Electrification Agency and the Small Business Administration; and the country wide network of the Extension Service Representatives of the Department of Agriculture. The following national agencies were selected as examples of the current and potential roles they and similar groups must share. The comments selected for each "group" were chosen to expand the readers positive viewpoint of the potential of each group rather than dwell on previous excesses, successes or singlemindednesses.

1. Department of Energy (DoE): This federal office will take the lead in resolving the energy problem. There is no reason to expect its imminent abolishment.

2. Department of Defense (DoD): Specific solutions which are implemented within the DoD can have a significant impact on the civilian/industrial community by setting



specifications, making quantity (but not on a national basis) purchases, and by publishing results at the local level.

3. Federal Laboratory Consortium /107: Consisting of over 180 laboratories, they can form a nucleus for a research development, test and evaluation of many alternate energy systems. A special effort of comparative test and evaluation together with publication of results should be considered.

4. Environmental Protection Agency (EPA): While too often involved in "anti \_\_\_\_\_" campaigns, their overall goals of protecting the future should not be minimized. Reduced air and water pollution have resulted. There is a correct concern of increased acid rain in the Midwest and the East Coast with any additional coal burning.

5. National Science Foundation (NSF): The NSF actively supports basic research in many fields and sponsors efforts to improve the communication and dissemination of technological information. Increased efforts to stimulate research and technological advances in all energy fields by the scientific community is necessary.

6. Department of Transportation (DoT): The DoT is able to determine an integrated (air/sea/rail/truck/automobile) transportation network which minimizes energy consumption. Optimum commercial and personal conveyances and a preferred utilization criteria for each mode can be developed once an energy efficient network is defined.

In addition, the capabilities of the nation's commercial and industrial base must be properly utilized and integrated into the total energy solution. Whether by government sponsorship, encouraged by government incentives or as a result of simple profit motivations, industry will provide the necessary technical expertise and production capabilities. The coordination of the many industrial specialties needed to resolve the energy problem might be based upon the common spokesmanship available through representative industrial associations.

The utility and energy industries provide either primary or secondary energy to practically every household and industry. Today and in the past, these companies have provided more and cheaper energy than is available anywhere else in the world. Whether one believes it was a result of profit and greed motives, the national interest, OPEC's or regulatory commission's pricing policies, or the dwindling of readily available supplies; energy prices paid by the user will be increased by these companies because they are in the business of providing and pricing the product they deliver. Competitive alternate sources of energy is the best control on the price of any one source if the energy consumer is concerned about the price of energy [9].

#### E. A POLL OF AMERICANS /247

In early 1980, the Union Carbide Corporation published an extensive poll of Americans' attitudes toward the energy problem. Because of the widespread effects energy has on individuals, the key results summarized below must be considered when envisioning and evaluating what the energy future is to be.

1. Americans agree on the need to reduce the nation's energy use and expect improvements in energy efficiency to achieve much of this saving. But they also expect that saving energy will require cutbacks in standards of living, and express concern about the equity with which these sacrifices will be distributed.

2. Americans support a pluralistic approach to the nation's energy future without undue reliance on any single energy option. Conservation is considered the fastest way to improve the nation's energy situation and is seen as one of the cheapest and most environmentally acceptable of the nation's energy options.

3. Homeowners consider cost the single most important obstacle they face in improving the energy efficiency of their homes. Of those who have made investments to improve the efficiency of their homes in the last two years, only three percent indicated that the present tax incentives for residential conservation played a major role in their decision. Up to 40 percent of America's homes could be candidates for

significant new or expanded conservation investments if a government incentive of \$750 is provided.

4. Americans feel that industry as well as government and "the average person" will help conserve energy. A majority believes that the energy prices, rather than government regulation, will induce industry to save energy. But a majority would support government incentives for industrial conservation if they were convinced such incentives would actually result in substantial new conservation by industry.

### III. SOURCES OF ENERGY CRITIQUED

Every attempt has been made to present the following review and comment of individual energy sources without bias. Although the negative aspects will often appear to be emphasized, this is because each has its obvious and well-known advantages. Also, the intention is to later develop a desired future model for which these energy sources must be considered.

#### A. CONSERVATION

Energy conservation has gradually come to include a wide-ranging group of activities:

Insulation	Energy use ratings on appliances
Reduced highway speeds	Increased use of trains and buses
Design trends	Reduced lighting levels
Room-in-use sensors	Fluorescent lamps in homes
Reduced-water shower heads	Underground homes
Cooler winter temperatures	Office windows that open
Fewer daily trips	Reflective windows

While each of these are energy conservation actions, the real goal is to increase the energy efficiency of each activity. Tremendous non-use savings are and will be gained through conservation efforts [5]. It should be assumed that new construction and equipments will incorporate available energy efficient concepts and that existing buildings and equipments

will be made more efficient. The result will be an eventual and predictable decline in the yearly percentage improvement of energy use efficiencies. Thus, conservation activities are very worthwhile short-term methods of saving energy through non-use, but provides only a partial solution for the long-run.

## B. DIRECT SOLAR

The sun can be shown to be the indirect cause of many alternate energy sources (wind, biomass, ocean effects). Here, the two key areas of Solar Heat and Solar Electricity are discussed with common residential and commercial/industrial applications in mind.

### 1. Solar Heat

Heat from the sun can be collected in many ways: A barrell painted black will get warm in the sun; active solar energy collection panels on rooftops are now providing hot water and/or space heating; and passive solar efforts are being increasingly integrated into new construction. However, when the sun sets or is blocked, heat is not collected and stored heat must be used if available. Thus, the two key factors involved with solar heat collection can be listed as:

- Efficiency in collecting the heat energy and
- The ability to store heat energy.

Efficiencies of solar heat collection methods impact directly on the cost-effectiveness projections of the systems. Improving efficiency would support economic aspects of solar

energy (shortened pay-back periods by using a smaller system) as well as the national/political goals of reduced crude oil imports. Three obvious areas for improving efficiencies that are yet to be fully developed are:

a. Sun tracking systems which can be used to either increase total energy collected or to reduce the size of the collection system. Partly because of low production rates, cost of these systems continue to be relatively high.

b. Use of "selective coatings" on collectors which, by more readily absorbing certain wavelengths of energy, increase the amount of heat energy collected. The higher costs of these efficiency improving coatings has slowed their widespread use.

c. Improved collector fluids which can remove heat from the collector surface more efficiently and would also offer freeze protection are needed. Several compounds have been developed (silicon based fluids) but their expense has limited their use.

The above discussions are based on the use of a liquid flat-plate collector system which has the advantage of flexibility in new applications as well as retrofits of all sizes. Passive design and air collection systems most often need to be included in the initial design and construction effort.

The need for heat storage efficiency improvements is primarily based on reducing the volume of the storage medium. While some products have recently entered the market /287,

neither production volumes nor product confidence has yet been achieved. Product testing, comparative economic analysis and expanded research is needed to reduce volume requirements and keep costs to a low level.

## 2. Solar Electricity

As with solar heat, the use of solar electricity systems requires a collection method and storage method. Solar collection (photovoltaic) cells are being researched by many firms in an effort to improve efficiency and/or find a mass production method which would lower total life-cycle costs to a competitive level. While periodic "breakthroughs" are announced, no sustained production program appears imminent /317/.

A possible reason for the less than full-scale solar cell effort is the simultaneous need for a light-weight, long-lived, cost-efficient and small-sized complimentary battery. Without this means of storing electricity, large scale production of solar cells would have a limited market.

## C. TRANSPORTATION

While not an energy source, transportation is such an obvious and unique user of energy that attention beyond the "conservation" aspects is needed. A mid-term to long-term view must include concepts for a vastly changed criteria for transportation utilization. The transportation of goods and the transportation of people are discussed separately.



Inexpensive fuels have, in the past, allowed for price-competitive products to be sold on one coast while being manufactured on the opposite coast. Transportation methods have been selected for expediency rather than costs. The current choice of transport modes will eventually be greatly altered as appropriate technology concepts bring manufacturing/production closer to individual market areas.

The movement of people will include a more stringent application of "distance traveled" criteria. Aircraft will be used for long distance and for middle distance travel where time is a factor. An improved rail system will interconnect major cities in the intermediate distance areas and buses will fan out to connect cities and tourist areas. The personal and family vehicle will be an electric car for short (total of 150-300 miles) ranges and/or hybrid vehicle capable of daily ranges of 600-800 miles. The shorter range electric vehicle will eventually be the most cost-efficient transportation mode available due to new battery design and use of solar cells for charging.

#### D. FOSSIL FUELS [19,20,39]

Be assured, whether it be crude oil, natural gas, coal tar sands or shale oil, the world will run out of it. Until that time, the price will increase continuously. If supplies are reduced before alternative energy sources are in wide use, the resulting priority systems (military having the number one

priority) will have tremendous effects on the nation's economic viability and political choices. Whereas today's energy and economic problems can be traced to reduce supplies of limited crude oil products, synthetic fuel processes are based on creating replacements for these limited crude oil products from other also limited sources. In addition to coal's environmental detriments of strip mining and contributions to the acid rain problem, many oil/gas fired electric generating plants are economically, physically and/or logistically unable to convert to coal. Assured oil/gas supplies must be maintained for these plants for many years to come. Additionally, fossil fuels are also used as feedstock in the plastics and fertilizer industries where alternatives may prove to be limited.

#### E. NUCLEAR ENERGY /15,37/

As a practical matter, the combined environmental, safety and political (location and weapons capability) problems of fission power seem insurmountable. This is despite the advantages offered by a non-fossil fuel energy source. It will be left to the development of the fusion reactors to provide the long-range needs of electricity (the first production unit on-line in 2050).

#### F. MISCELLANEOUS SYSTEMS

The following systems are grouped together because no one system will become a major energy source. However, when totaled,

they will be significant. A common element of these systems is that they should be considered and used based on local rather than national conditions. A process useful in Miami might not be useful in Chicago and the inefficiencies of energy transmission and the expense of scale make it only useful in the immediate Miami area. Thus, these are the concepts where the following criteria should be applied: if it is a locally available, non-fossil fuel, cost-efficient system; use it locally.

1. Geothermal: Its potential will be enhanced by recent heat exchanger concepts which will reduce the current environmental problems of noise and odor [11,12].

2. Wind Generators [23]: These devices, when large scale units are produced, have potential reliability problems and local environmental impacts. Despite careful selection of site locations, power generation can not be guaranteed without a secondary storage and generating capability (use wind power to pump water to a higher location and then use hydroelectric systems to generate electricity). Wind power might best be used where high power uses could be timed or delayed to coincide with power available from the wind (aeration of ponds, irrigation). Small scale units to supplement the charging of batteries may also be a practical application.

3. Biomass: Where methane or alcohol is a practical by-product of an on-going process (refuse or crop residue disposal), its inclusion into an over-all energy use scenario

should be included. Environmentally desirable processes which convert refuse into gasoline [3], methane or fuel pellets should be actively pursued in population centers. However, consideration of large scale national "energy farms" would not be politically acceptable due to the removal of thousands of acres from food production [4].

4. Ocean Power: This source is based on the energy available from ocean tides, waves, current and thermal differences. Although tides have been used in Europe for generating electricity (very similar to hydroelectric plant operation), the technology for the remaining modes are in various stages of research and development. Because of the unique oceanographic requirements and costs of each system, their application will be limited.

5. Small Hydroelectric Systems: Although most of the cost effective large hydroelectric/dam sites have been built upon, a tremendous potential exists for communities and/or local governments to use local dams and rivers for small scale hydroelectric systems. Not only might a degree of independence from ever rising energy prices be gained, but a reduction in pressure for new generating plants would also serve the national goals.

#### G. HYDROGEN

The potential of hydrogen as an accepted and practical energy source has only recently been receiving serious

consideration. An early technological breakthrough could change the energy industry overnight. Until the transportability concerns are overcome, the initial applications would be one of the following:

- Hydrogen as a replacement for fossil fuels in large-scale power/industrial plants.
- Direct conversion to electricity using Oxygen-Hydrogen fuel cells and/or hydrogen ionization from sunlight.
- Hydrogen as an aircraft fuel.

#### H. COGENERATION

This term is applied to the specific efforts to consider second and third applications of an energy source or a by-product of the source. For example:

1. Waste heat from a power plant can be used to provide space heating and hot water to nearby office and commercial buildings.
2. Hydro-power whose energy for electric power generation has been depleted might still be used for other tasks (pumping, aeration of ponds).

While extensively applied in Europe, applications in this country have lagged. Added practical engineering efforts will occur because the cost of the primary energy source can be shared by secondary and tertiary users.

#### I. OTHER ALTERNATIVES

As conservation was not a true energy source, a choice to restrict one's lifestyle or sacrifice current options and products can also "free-up" energy for other uses. This may

not be a matter of choice if the wrong decisions on our energy future are made.

#### IV. AN ENERGY FUTURE

The preceding chapters have been primarily informational. Concepts, both practical and philosophical, have been presented; a broadening of knowledge has been attempted; and alternate ways to view old terms and ideas identified: all with a specific purpose in mind. It has been proposed that only now can a desired future model be defined and, with this available, action policies can then be chosen to achieve this future state.

##### A. FUTURE MODEL

The chosen Future Model is a positive state: only small steps from being achievable with today's technology. It identifies inevitable situations. Four user sub-groups stand out as requiring separate but coordinated consideration.

1. The Small-to-Medium Energy User (included is the individual and his residence, and commercial and light industrial /and portions of heavy industrial complexes/ facilities): The primary commitment of this group may be summarized as "maximum energy independence." All personal and business decisions will be based on avoiding the use of outside energy sources whether heat, electricity or transportation. Any need for outside energy will be limited and will always be used during off-peak hours since storage capability will be available.

2. The Large Energy User (primarily consisting of medium and heavy industrial applications): This group of industries would not be able to achieve a significant level of energy self-sufficiency for their main function/product. Most of these facilities would remain dependent on commercial energy suppliers. As a result of energy demand leveling actions, industrial activity would be phased-in and phased-out around the clock with the less desirable time periods rotated among users. Some heavy industries may well construct their own power supplies if located near a potential source.

3. Military Equipments (this excludes those military shore based facilities which can be viewed as falling into either of the above two categories): Military land, sea and air combat capable vehicles performing functions similar to today's vehicles will continue to be powered by fuels very similar to those used today. Only new concept equipments (transport dirigibles with self-contained combat aircraft) might use the more exotic hydrogen fuels. Performance characteristics of the equipment will not be noticeably affected whether using fuel from a natural crude oil or from a synthetic base anywhere in the world. The military must have assured long-term supplies of fuel [21].

4. Energy Suppliers (fuel oil, gasoline/diesel, natural gas and electric [all sources] producers comprise this group): Capacity expansion is no longer a primary goal and, in some instances, total capacity has been reduced. Strategic planning



and efforts are based on providing and servicing equipments for the small to medium energy user. Fuel oil, natural gas and gasoline/diesel will have limited roles beyond the making of electricity, heavy industrial needs and the military. Electricity producers will provide continuous emergency/back-up connections at a fixed fee. Their primary purpose will be in support of the medium to heavy industrial users.

#### B. ENERGY POLICIES AND ACTIONS

No one person in an article or book can provide a complete detailed and scheduled action-by-action solution to the energy problem. The intention here is, based on achieving the defined energy future, to cite those policies which can best form the bounds of resolution. This is followed by a group of action items which would best begin to implement these policies.

##### 1. Policies

The following policy statements should be used to form the basis for deciding all actions to be taken on energy.

a. The national economy must be able to expand without personal sacrifices by individuals because of any government policy.

b. The achievement of maximum energy independence for individuals and for commercial/industrial facilities in the shortest possible time frame.

c. New but still profitable roles will need to be defined by utility and energy companies with the support of governments and their agents.

d. Educational and informational activities for all fields of energy shall be supported and funded.

e. Government laboratories and industrial facilities will become information dissemination and testing centers.

f. Governments and government agencies shall not be excluded from meeting energy related standards and, in fact, shall be responsible for taking the lead in achieving energy independence.

g. All levels of government shall enact tax, zoning or other types of laws and regulations which enhance the meeting of the other policies and which actively encourages their achievement.

## 2. Actions

Within the bounds of the preceding policy guidelines and the information previously presented and analyzed, the following priority actions are recommended. While other energy programs and activities should also be funded, those listed are considered the most efficient when the total people-time-money commitments are analyzed.

a. The government shall procure supplies of selective coatings and provide it free to solar collector manufacturers and homeowners building their own systems. When available, a similar program will be established for new heat transfer fluids.

b. The government shall make it a national priority program to develop the following:

- Inexpensive, freeze-proof, highly efficient heat transfer fluids.
- Inexpensive, efficient, minimum volume heat storage systems.
- Inexpensive, efficient, long-lasting battery storage systems.
- Inexpensive, efficient, reliable solar (photovoltaic) cells.

Research, development, test and evaluation grants for these efforts will require at least a limited licensing of patents if not immediately given to the public domain.

c. Increased tax advantages to encourage energy efficient conservation installations. Government supported short-term, low-interest, no-limit loans should be made available to all for these short pay-back period items.

d. The Department of Defense will immediately begin a solar collection and storage program. Also, it will initiate a wide-ranging conservation program at all bases. A secondary purpose will be local community demonstration and the qualification of locally available equipments.

e. Several series of educational shows will be sponsored by the government for use by both the Public Broadcasting System and commercial television. In addition, commercial television will include an explanation of energy sources; ways to analyze, select and install energy conservation devices; and consumer fraud/reporting. Classroom

credit courses will be prepared for teaching vocational energy skills and energy management.

f. The new Education Department will issue guidelines for all levels of education to allow an energy curriculum to be developed for every institution.

g. Governmental leaders need to issue directives to each agency and department to review its policies and regulations and to initiate phased changes wherever any energy inefficient areas are found.

h. Priority supplemental budget procedures will be established for each government agency/department to install energy conservation devices in their own facilities. These procedures must reduce the normal three to five year budget cycle in order to begin immediate energy use reductions.

i. Government agencies having loan and grant authority shall make energy conservation and energy independence a primary criteria for award.

j. The following Task Forces need to be appointed/established in order to search out the best solution for each area:

- Utility and Energy Company Task Force: The goal is to determine ways to ease the transition to the new energy independence environment and to find new areas in the energy field that can be both profitable and in the national interest.

- Automobile Industry Task Force: Goals are to analyze tax credits for converting the automobile industry to electric and/or hybrid car production. The group would identify the tax and subsidy scenarios that would assure its earliest accomplishment.
- Energy Tax and Subsidy Task Force: The goal is to assure that it will be cost-effective to install solar heat and electricity collection and storage systems as soon as production testing is under way.
- Government Actions Task Force: All levels of government will be analyzed and baseline energy policy and action recommendations prepared for state, county and city governments. Minimum mandatory actions for federal agencies will be readied for implementation by Presidential Directive.

## V. CONCLUDING REMARKS

The processes developed in this paper have provided the reader with a methodology for the individualized assessment of this nation's energy situation in light of world, national, state, local and individual needs. Despite inherent complexities, it has been demonstrated how, upon choosing an energy future, governmental policies and actions can become logically supportive of this chosen model. While demonstrated primarily for the policies of the federal government, a similar methodology can be used by all echelons of government and industry for overcoming their energy problem.

The Future Model selected in this paper can be logically supported without resorting to current or future energy supply, usage or cost/price projections. This is advantageous because of the conflicting claims published by various authorities. A simplified set of assumptions for the selected energy future state would be as follows:

- Fossil fuels are limited in supply and their real or perceived depletion rate will result in their steadily increasing price,
- A world view of energy needs and usage is mandatory [29],
- The military has a long-term need for fossil fuel based products, and
- The individual will seek energy independence at the earliest practical time.

The policies and actions chosen to implement this energy future are neither radical nor utopian. They may be easily implemented within current organizational structures and within a short period of time. The future of the United States is dependent on a concise and immediate choice of an energy future.

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